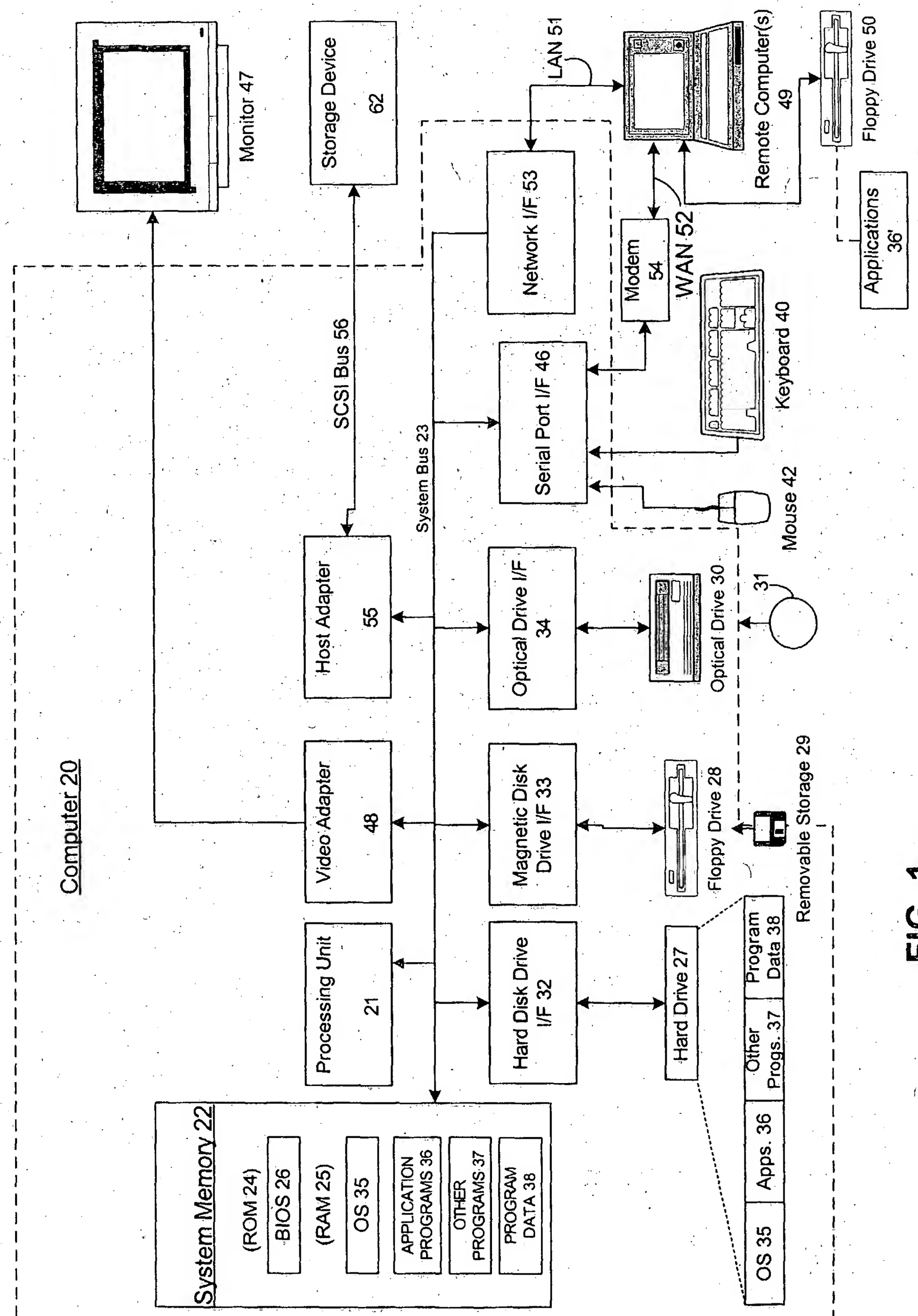

Monitor 47
Storage Device 62
LAN 51
Remote Computer(s) 49
Floppy Drive 50
Applications 36'
Network I/F 53
Modem 54
WAN 52
Keyboard 40
SCSI Bus 56
Serial Port I/F 46
System Bus 23
Host Adapter 55
Optical Drive I/F 34
Mouse 42
Optical Drive 30
31
Video Adapter 48
Magnetic Disk Drive I/F 33
Floppy Drive 28
Removable Storage 29
Computer 20
Processing Unit 21
Hard Disk Drive I/F 32
Hard Drive 27
System Memory 22
(ROM 24)
BIOS 26
(RAM 25)
OS 35
APPLICATION PROGRAMS 36
OTHER PROGRAMS 37
PROGRAM DATA 38
OS 35
Apps. 36
Other Progs. 37
Program Data 38

FIG. 1

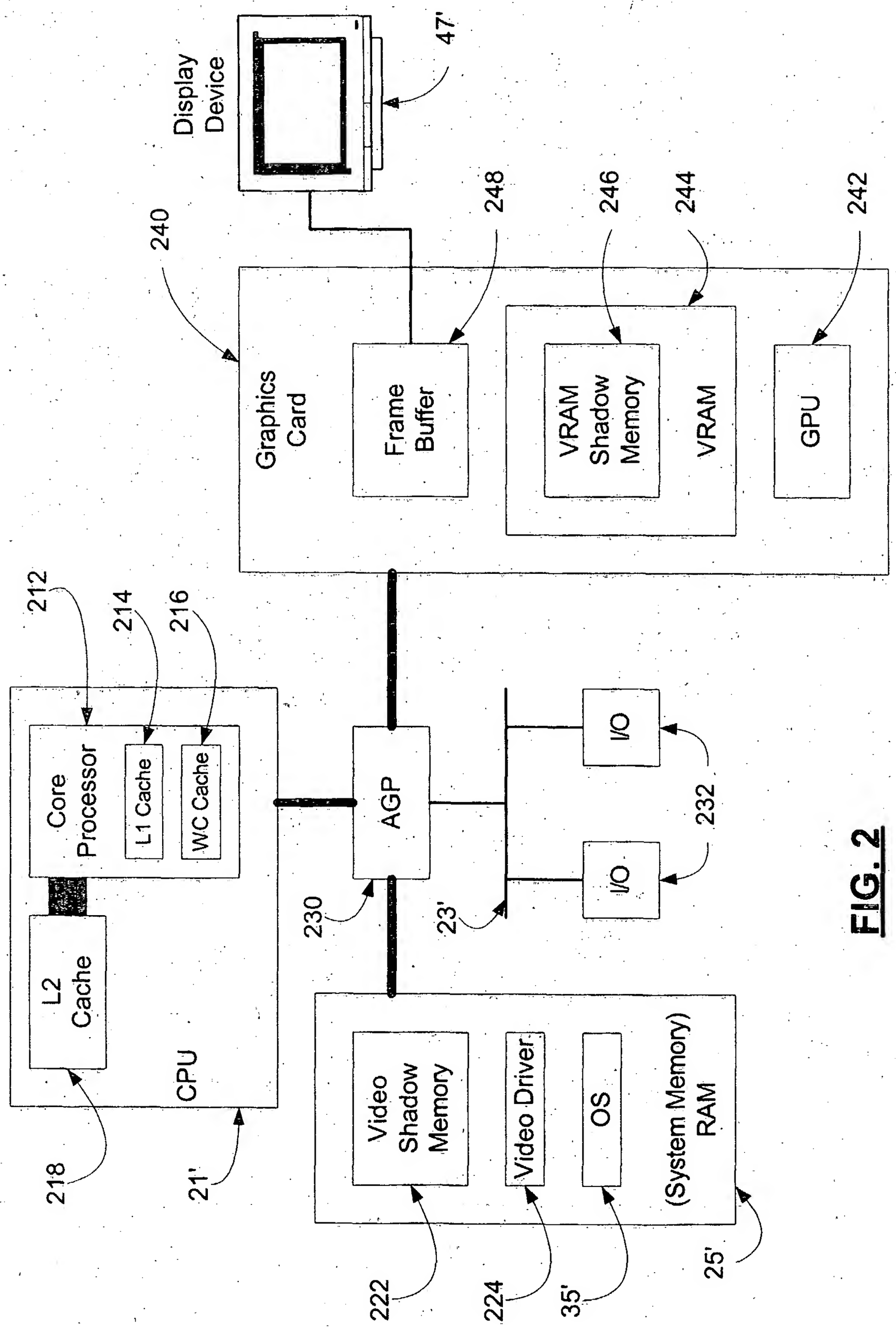

Display Device
47'
240
248
246
244
242
Graphics Card
Frame Buffer
VRAM Shadow Memory
VRAM
GPU
212
214
216
Core Processor
L1 Cache
WC Cache
L2 Cache
CPU
AGP
230
23'
I/O
I/O
232
218
21'
Video Shadow Memory
Video Driver
OS
(System Memory) RAM
222
224
35'
25'

FIG. 2

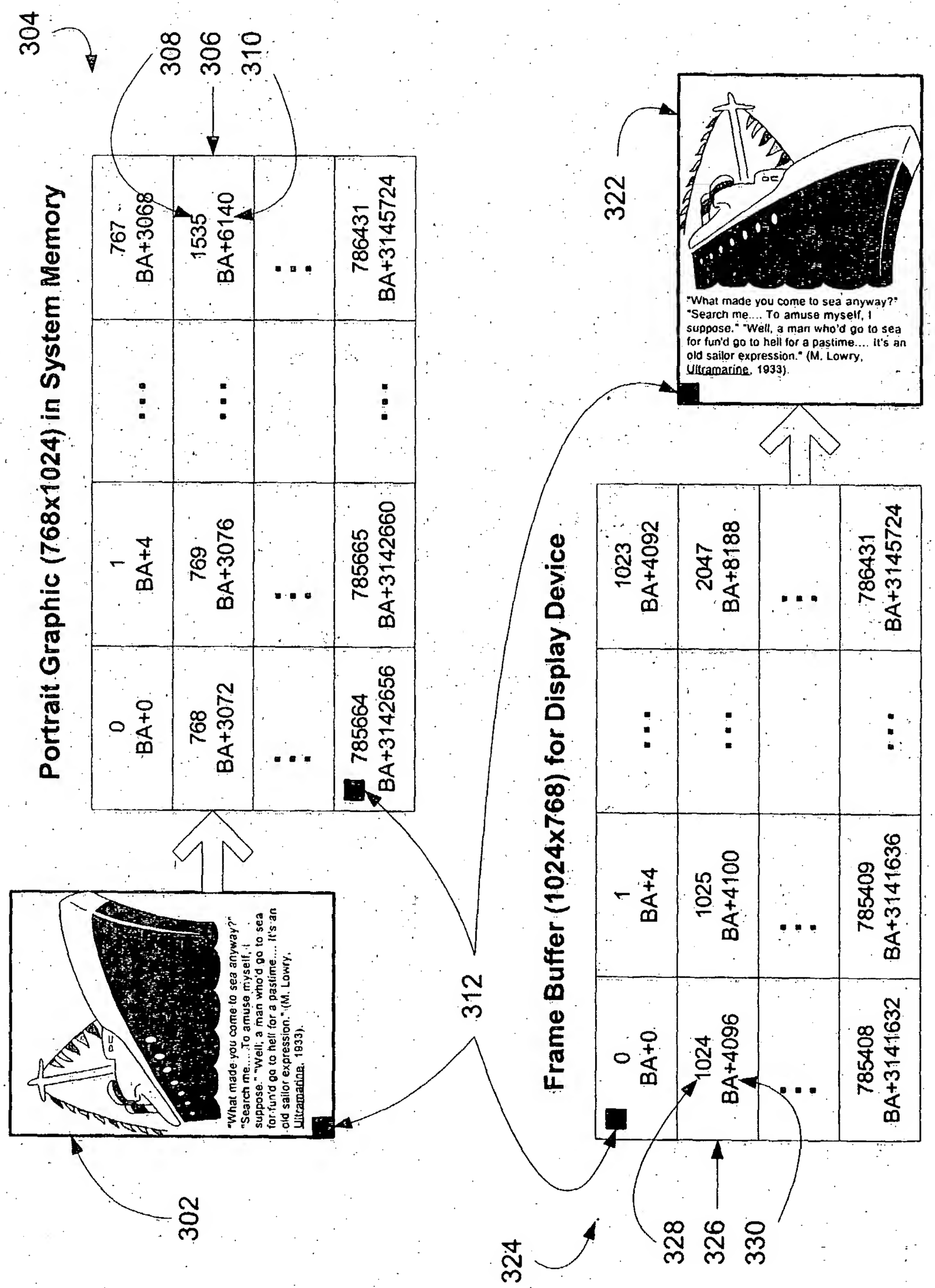

304
308
306
310
Portrait Graphic (768x1024) in System Memory
0 BA+0
1 BA+4
767 BA+3068
768 BA+3072
769 BA+3076
1535 BA+6140
785664 BA+3142656
785665 BA+3142660
786431 BA+3145724
"What made you come to sea anyway?" "Search me.... To amuse myself, I suppose." "Well, a man who'd go to sea for fun'd go to hell for a pastime.... It's an old sailor expression." (M. Lowry, Ultramarine, 1933).
302
312
322
Frame Buffer (1024x768) for Display Device
0 BA+0
1 BA+4
1023 BA+4092
1024 BA+4096
1025 BA+4100
2047 BA+8188
785408 BA+3141632
785409 BA+3141636
786431 BA+3145724
324
328
326
330

FIG. 3A

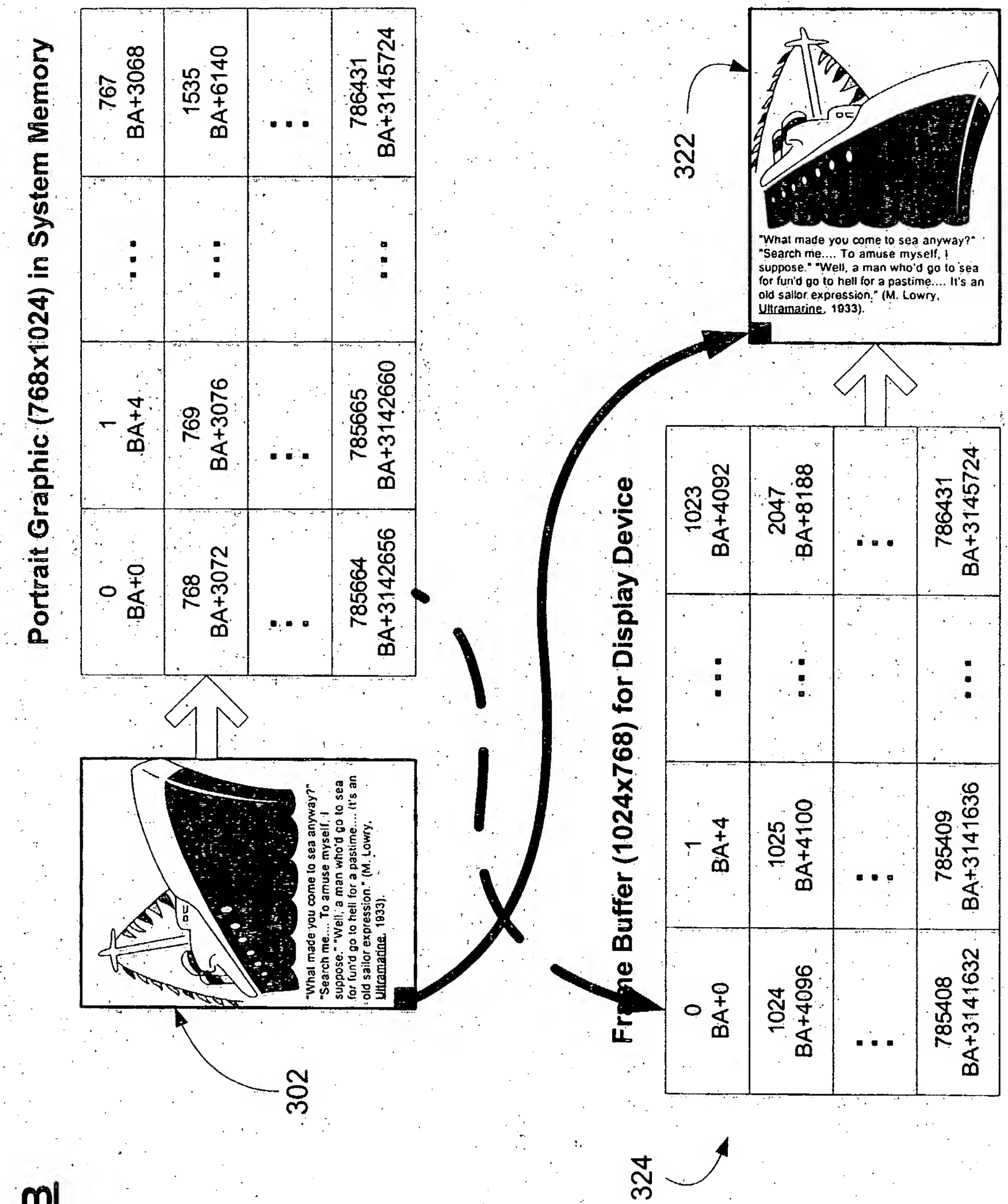

304
Portrait Graphic (768x1024) in System Memory
0 BA+0
1 BA+4
767 BA+3068
768 BA+3072
769 BA+3076
1535 BA+6140
785664 BA+3142656
785665 BA+3142660
786431 BA+3145724
"What made you come to sea anyway?" "Search me.... To amuse myself, I suppose." "Well, a man who'd go to sea for fun'd go to hell for a pastime.... It's an old sailor expression." (M. Lowry, Ultramarine, 1933).
302
322
"What made you come to sea anyway?" "Search me.... To amuse myself, I suppose." "Well, a man who'd go to sea for fun'd go to hell for a pastime.... It's an old sailor expression," (M. Lowry, Ultramarine, 1933).
Fr... Buffer (1024x768) for Display Device
0 BA+0
1 BA+4
1023 BA+4092
1024 BA+4096
1025 BA+4100
2047 BA+8188
785408 BA+3141632
785409 BA+3141636
786431 BA+3145724
324

FIG. 3B

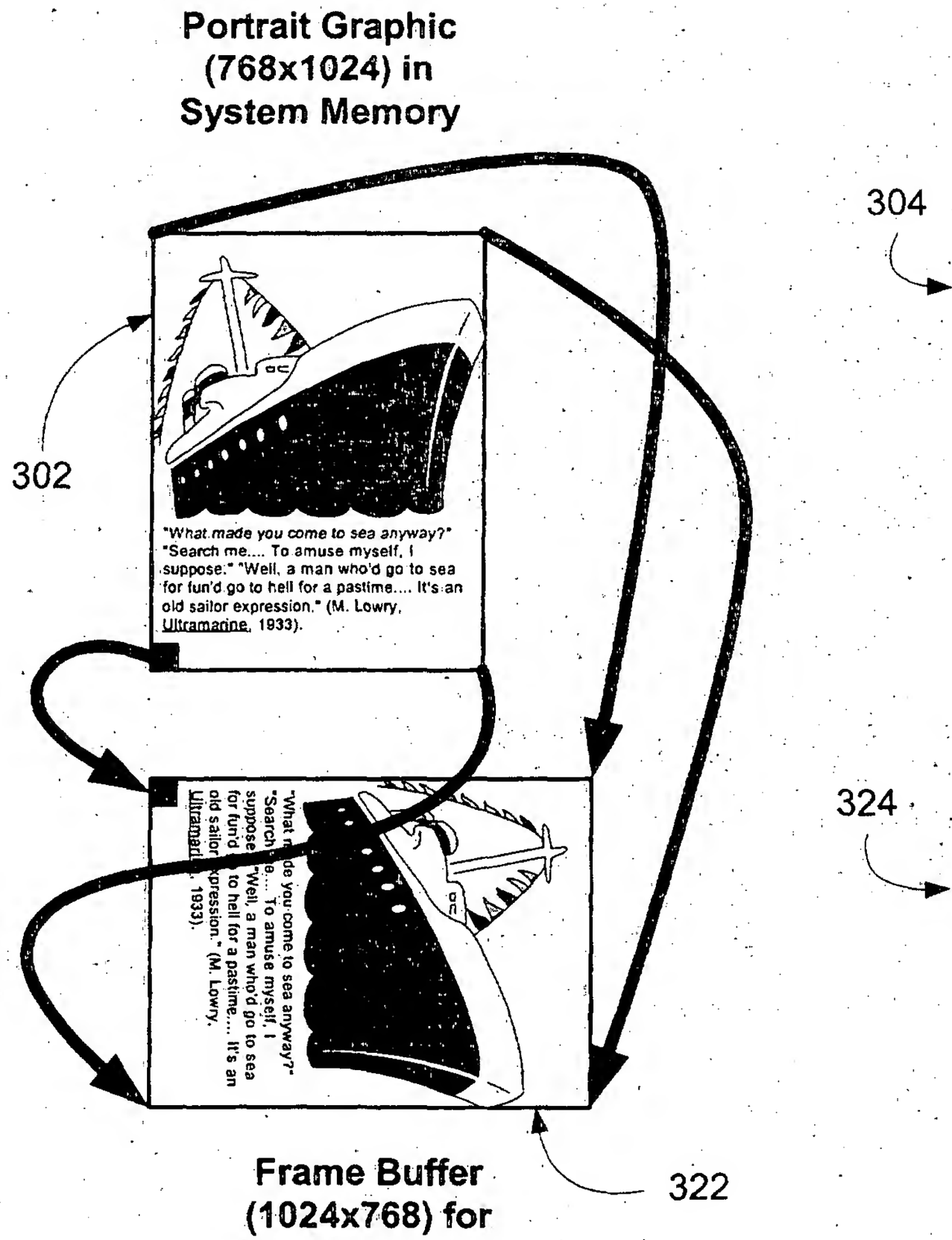
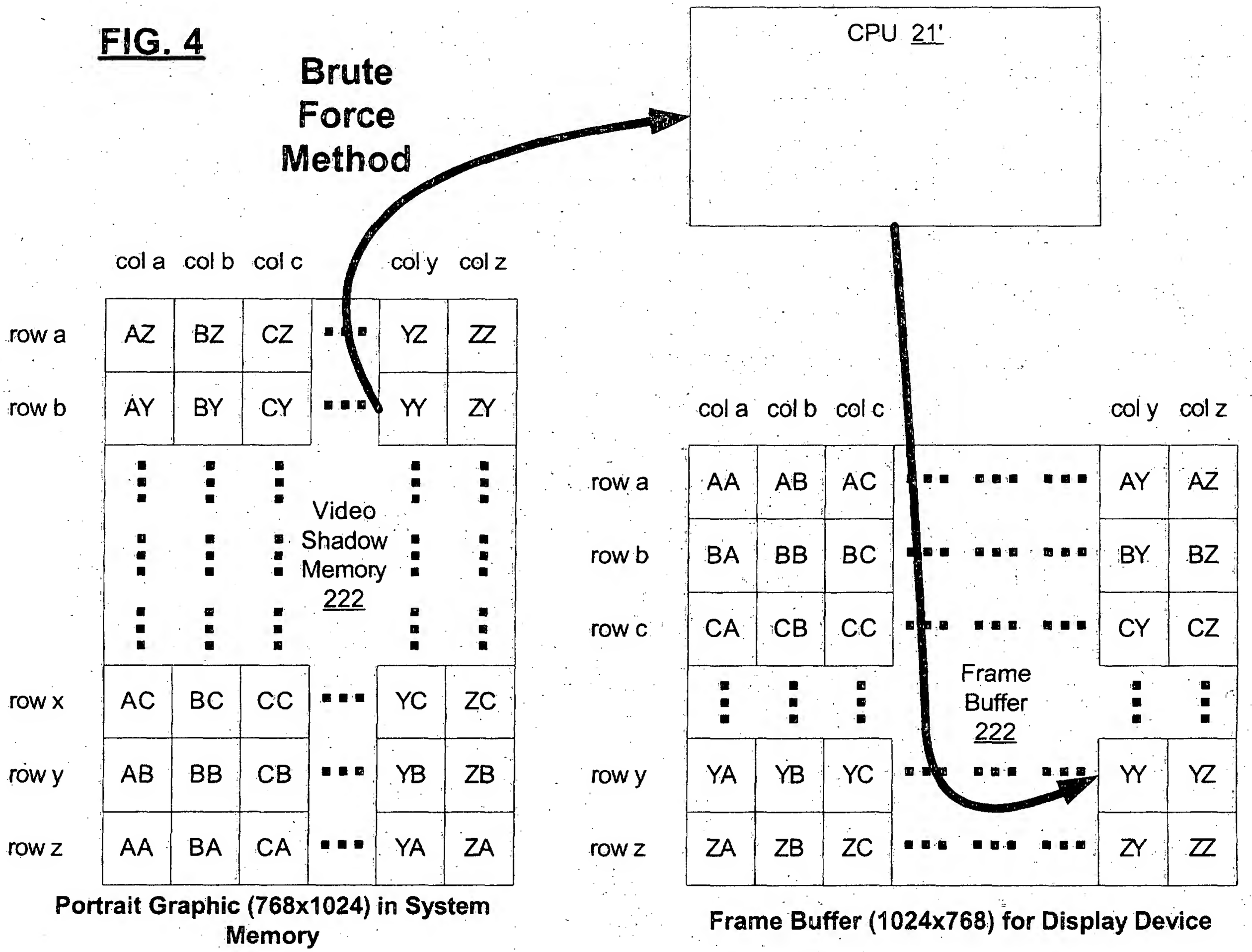

Portrait Graphic (768x1024) in System Memory
302
"What made you come to sea anyway?" "Search me.... To amuse myself, I suppose." "Well, a man who'd go to sea for fun'd go to hell for a pastime.... It's an old sailor expression." (M. Lowry, Ultramarine, 1933).
Frame Buffer (1024x768) for Display Device
322
304
Portrait Graphic (768x1024) in System Memory
0 BA+0
1 BA+4
767 BA+3068
768 BA+3072
769 BA+3076
1535 BA+6140
785664 BA+3142656
785665 BA+3142660
786431 BA+3145724
324
0 BA+0
1 BA+4
1023 BA+4092
1024 BA+4096
1025 BA+4100
2047 BA+8188
785408 BA+3141632
785409 BA+3141636
786431 BA+3145724
Frame Buffer (1024x768) for Display Device

FIG. 3C

**FIG. 4**

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Inventor: Donald D. Karlov
Attorney: Richard W. Knight Phone: (215) 568-3100
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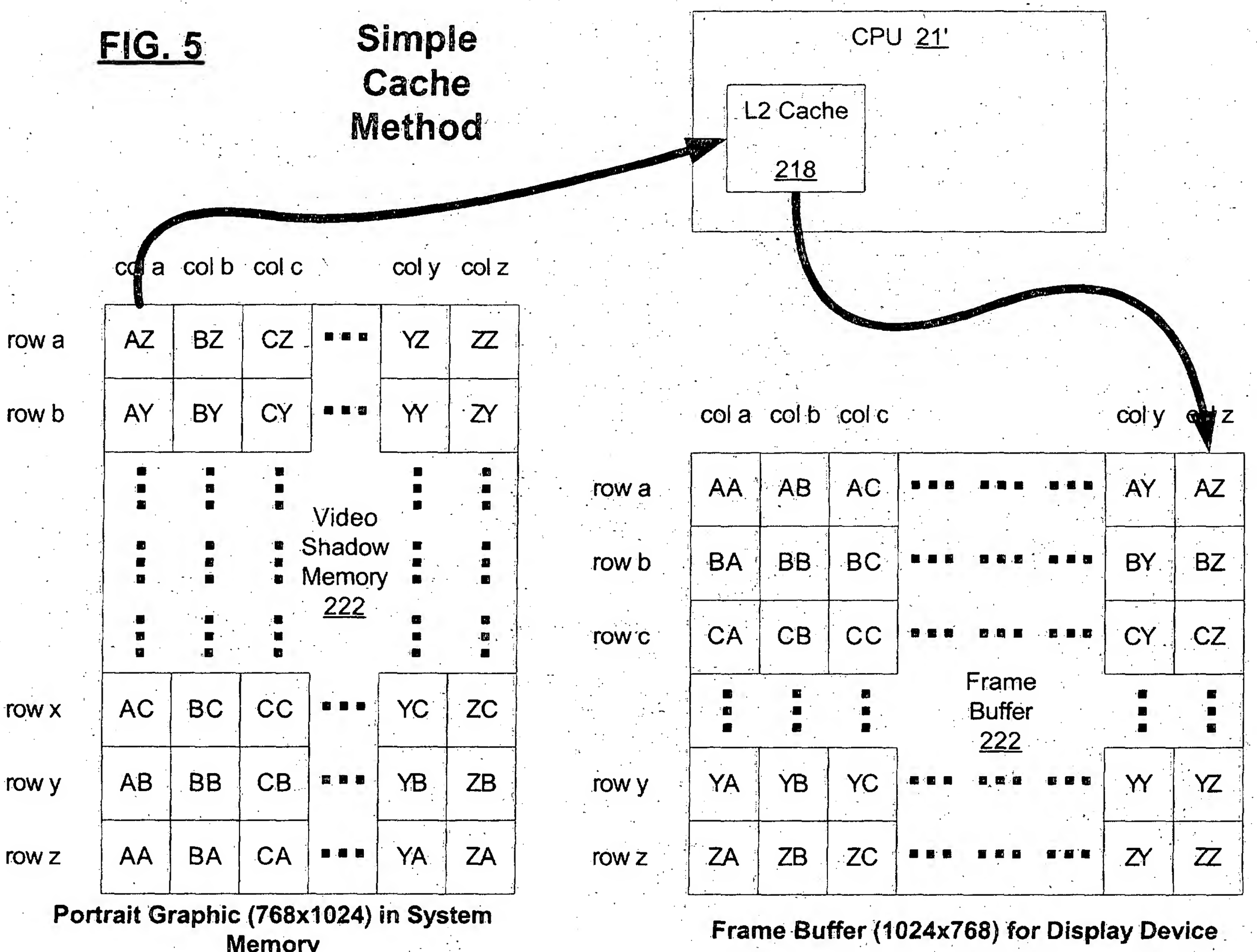
**FIG. 5**

**Simple Cache Method**




**Portrait Graphic (768x1024) in System Memory**

**Frame Buffer (1024x768) for Display Device**

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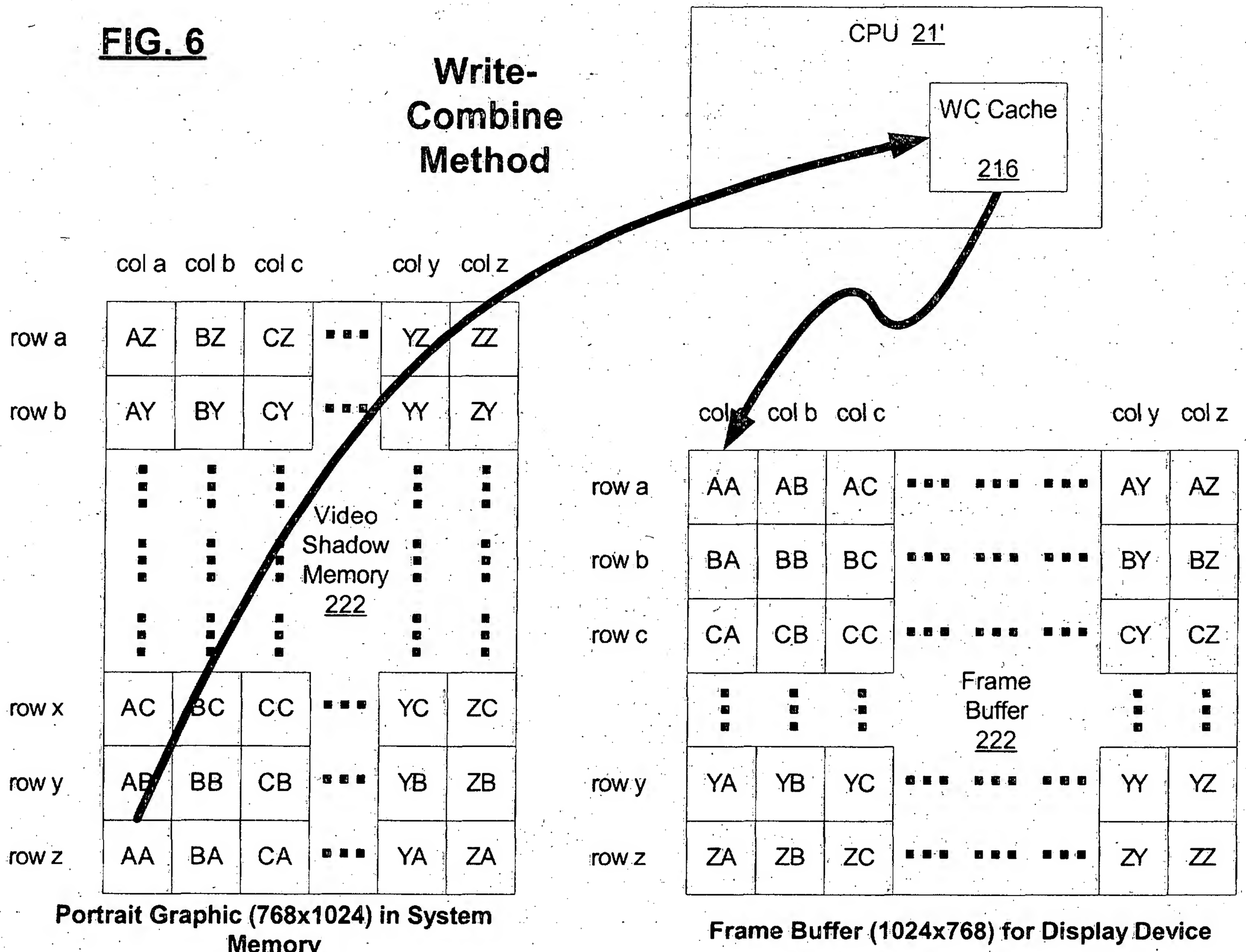
**FIG. 6**




**Portrait Graphic (768x1024) in System Memory**

**Frame Buffer (1024x768) for Display Device**

**FIG. 7A**

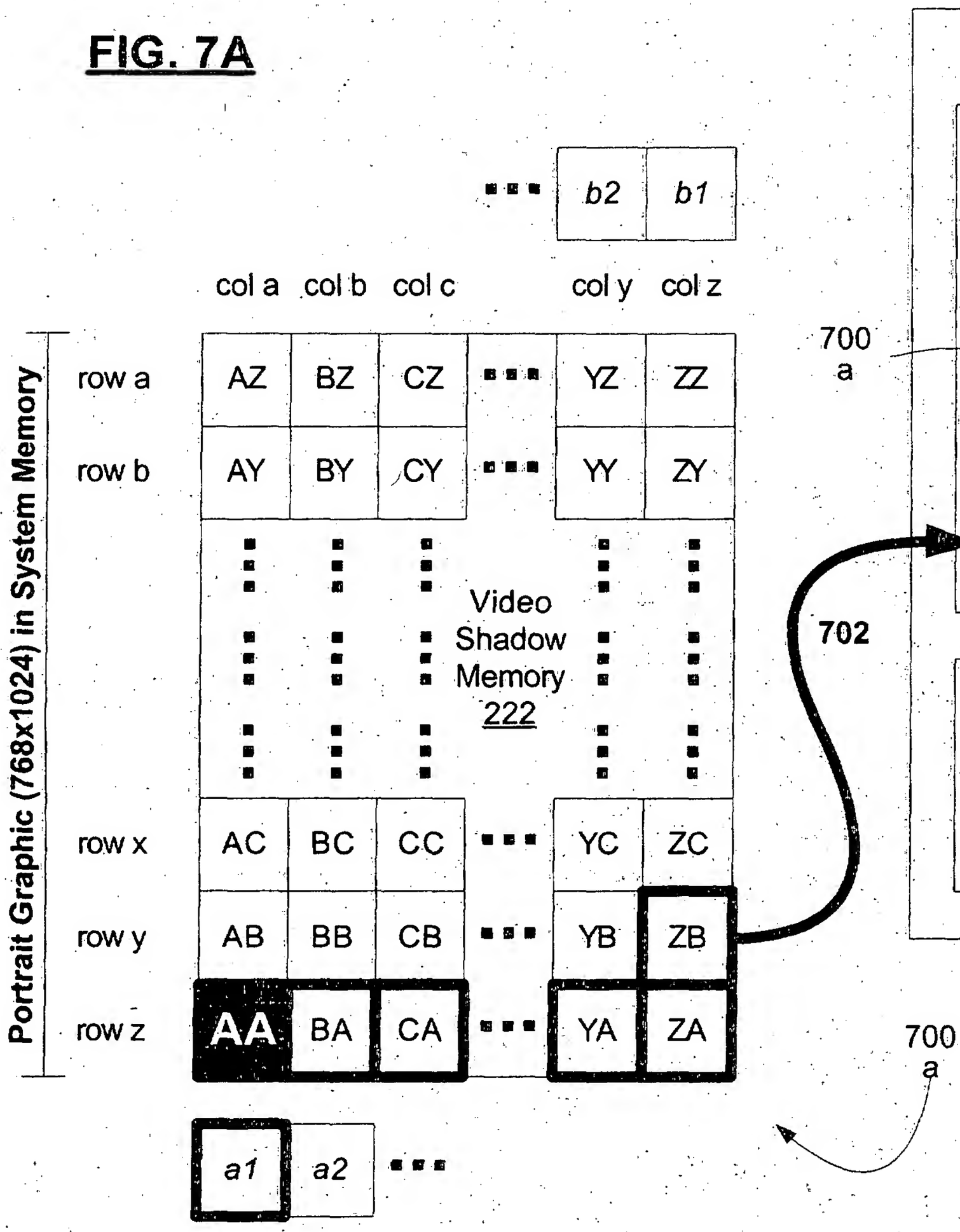
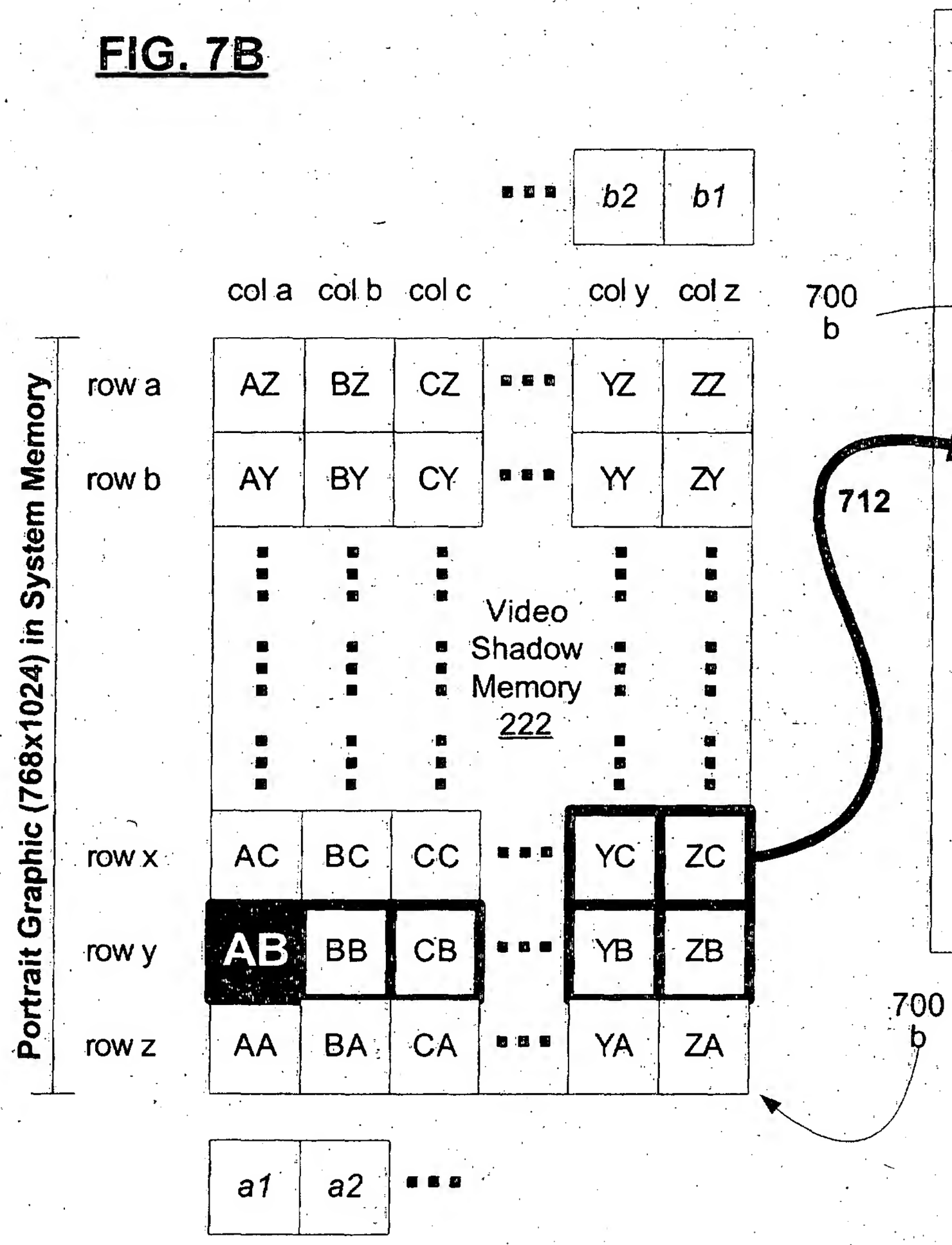
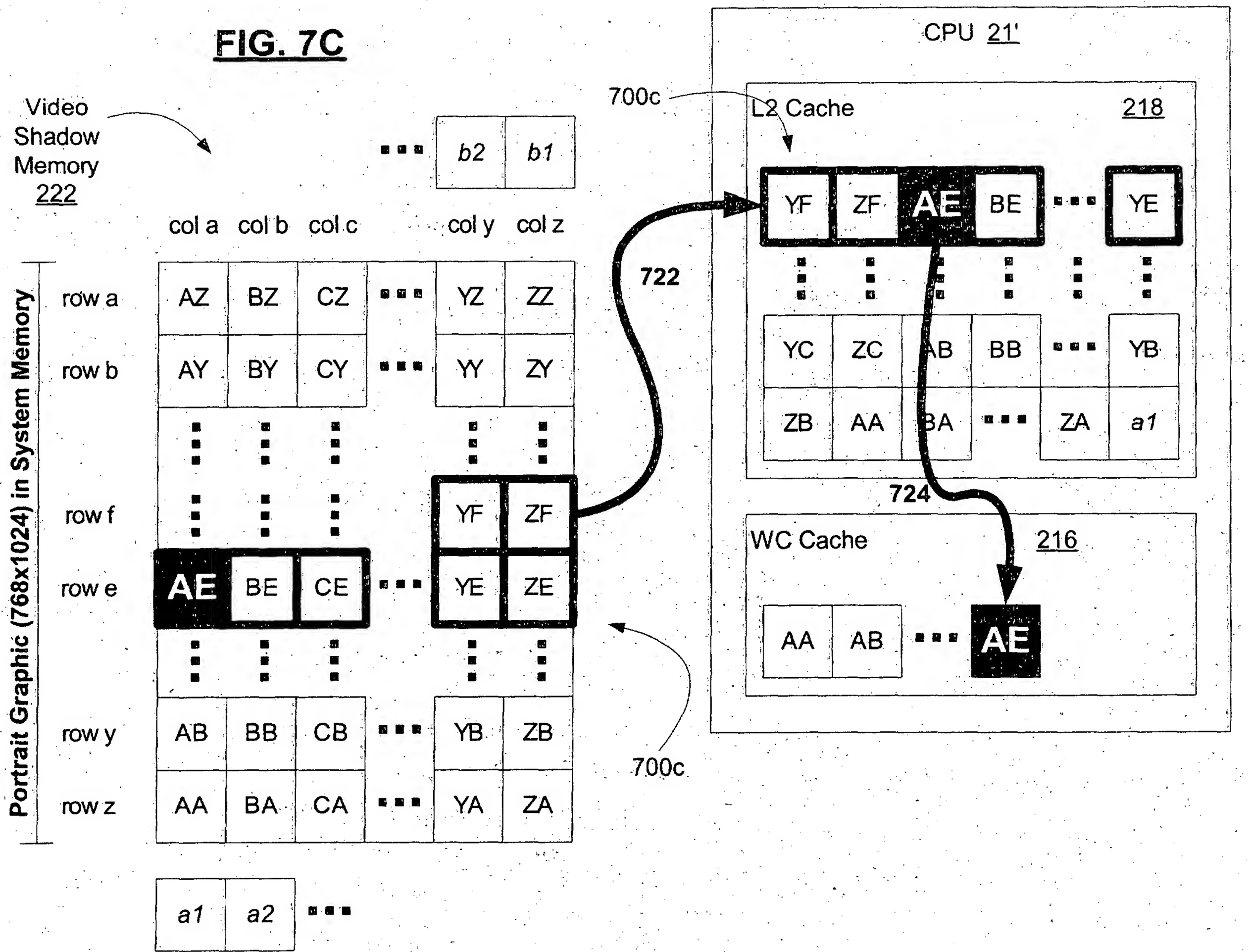

b2
b1
col a
col b
col c
col y
col z
row a
row b
AZ
BZ
CZ
YZ
ZZ
AY
BY
CY
YY
ZY
Video Shadow Memory 222
row x
row y
row z
AC
BC
CC
YC
ZC
AB
BB
CB
YB
ZB
AA
BA
CA
YA
ZA
a1
a2
Portrait Graphic (768x1024) in System Memory
CPU 21'
L2 Cache 218
700 a
ZB
AA
BA
ZA
a1
702
704
WC Cache 216
AA
700 a

**FIG. 7B**


b2
b1
col a
col b
col c
col y
col z
row a
row b
row x
row y
row z
AZ
BZ
CZ
YZ
ZZ
AY
BY
CY
YY
ZY
AC
BC
CC
YC
ZC
AB
BB
CB
YB
ZB
AA
BA
CA
YA
ZA
Video Shadow Memory 222
Portrait Graphic (768x1024) in System Memory
a1
a2
700 b
712
714
CPU 21'
L2 Cache 218
YC
ZC
AB
BB
YB
ZB
AA
BA
ZA
a1
WC Cache 216
AA
AB

# FIG. 7C





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# FIG. 7D

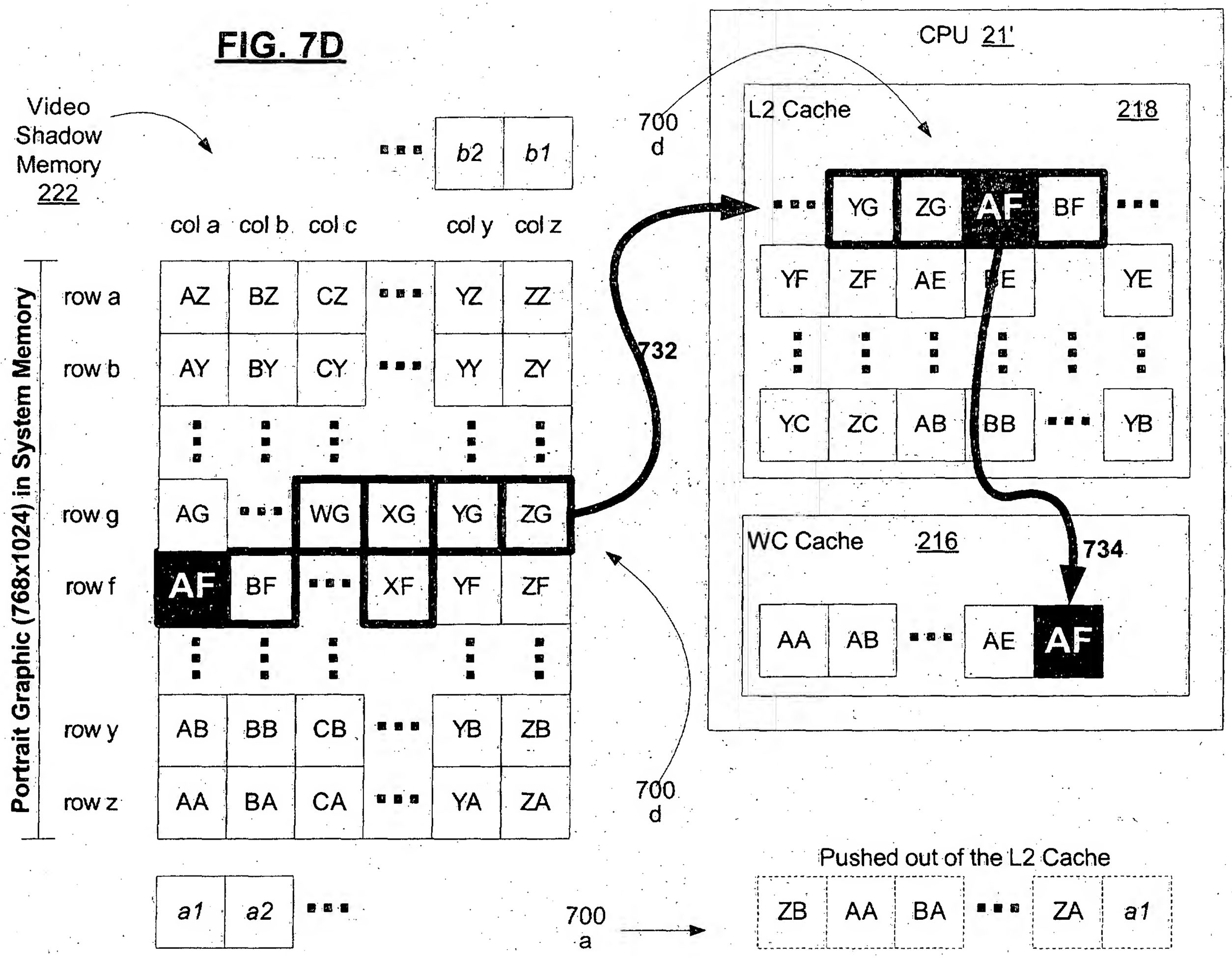
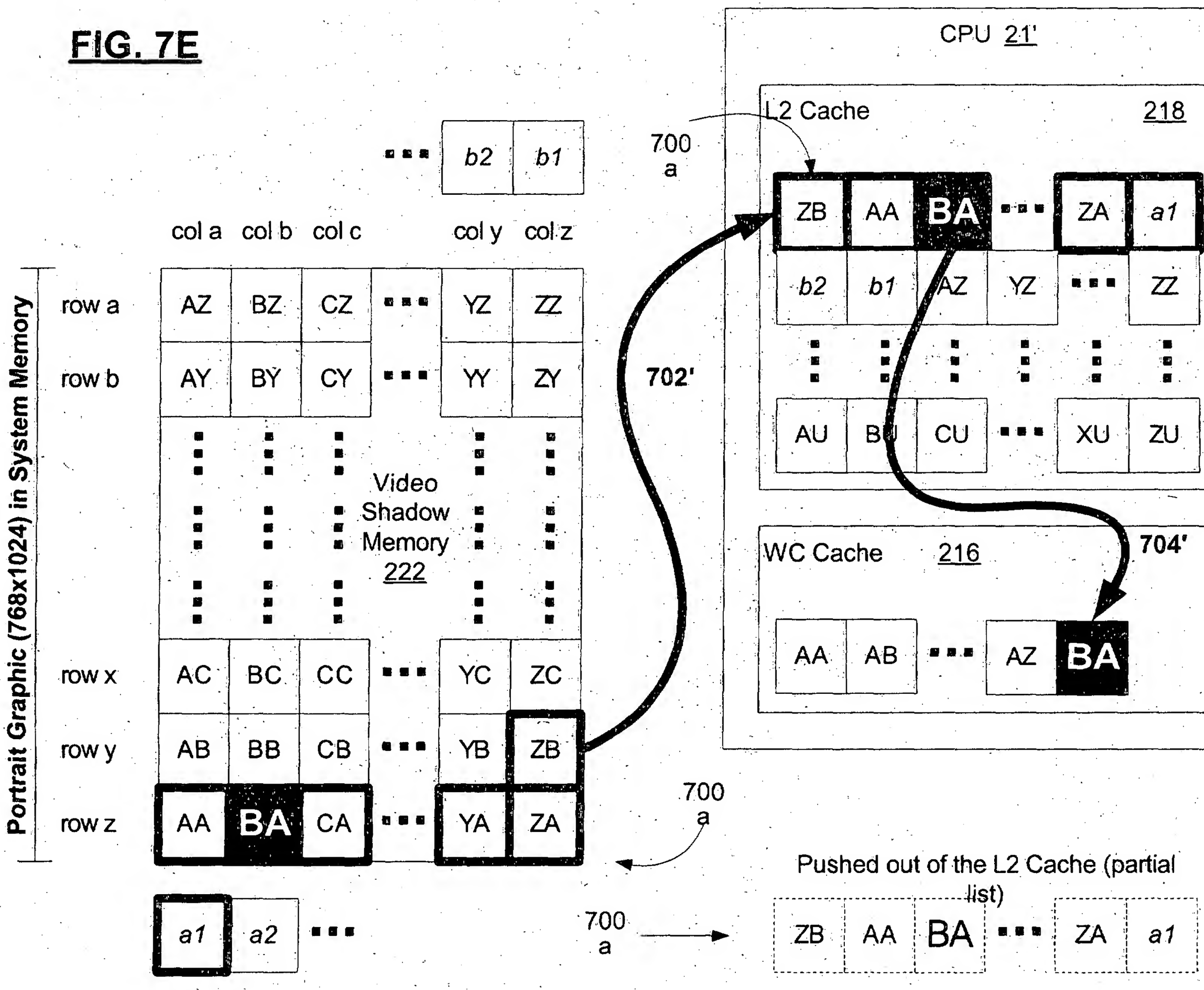

Video Shadow Memory 222
col a
col b
col c
col y
col z
row a
row b
row g
row f
row y
row z
Portrait Graphic (768x1024) in System Memory
b2
b1
AZ BZ CZ YZ ZZ
AY BY CY YY ZY
AG WG XG YG ZG
AF BF XF YF ZF
AB BB CB YB ZB
AA BA CA YA ZA
a1
a2
700 d
732
700 d
700 a
CPU 21'
L2 Cache 218
YG ZG AF BF
YF ZF AE BE YE
YC ZC AB BB YB
WC Cache 216
734
AA AB AE AF
Pushed out of the L2 Cache
ZB AA BA ZA a1

FIG. 7E


CPU 21'
L2 Cache
218
700
a
ZB AA BA ... ZA a1
b2 b1 AZ YZ ... ZZ
AU BU CU ... XU ZU
702'
WC Cache 216
704'
AA AB ... AZ BA
Portrait Graphic (768x1024) in System Memory
col a col b col c col y col z
row a AZ BZ CZ YZ ZZ
row b AY BY CY YY ZY
Video Shadow Memory 222
row x AC BC CC YC ZC
row y AB BB CB YB ZB
row z AA BA CA YA ZA
b2 b1
a1 a2
700
a
Pushed out of the L2 Cache (partial list)
ZB AA BA ... ZA a1

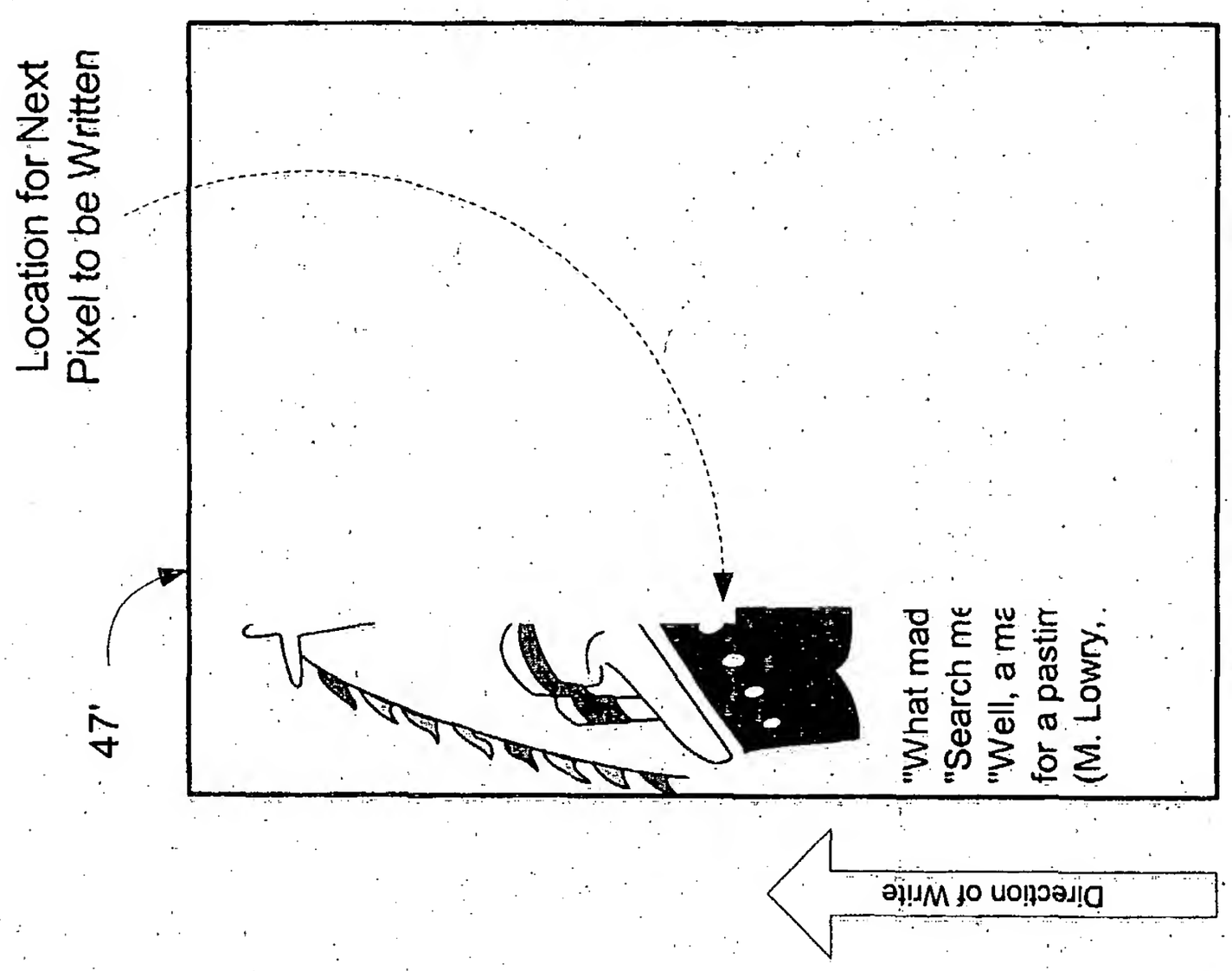

Location for Next Pixel to be Written
47'
"What mad
"Search me
"Well, a ma
for a pastin
(M. Lowry,
Direction of Write
Portrait Graphic (768x1024)
on Portrait-Oriented Display Device

FIG. 8B

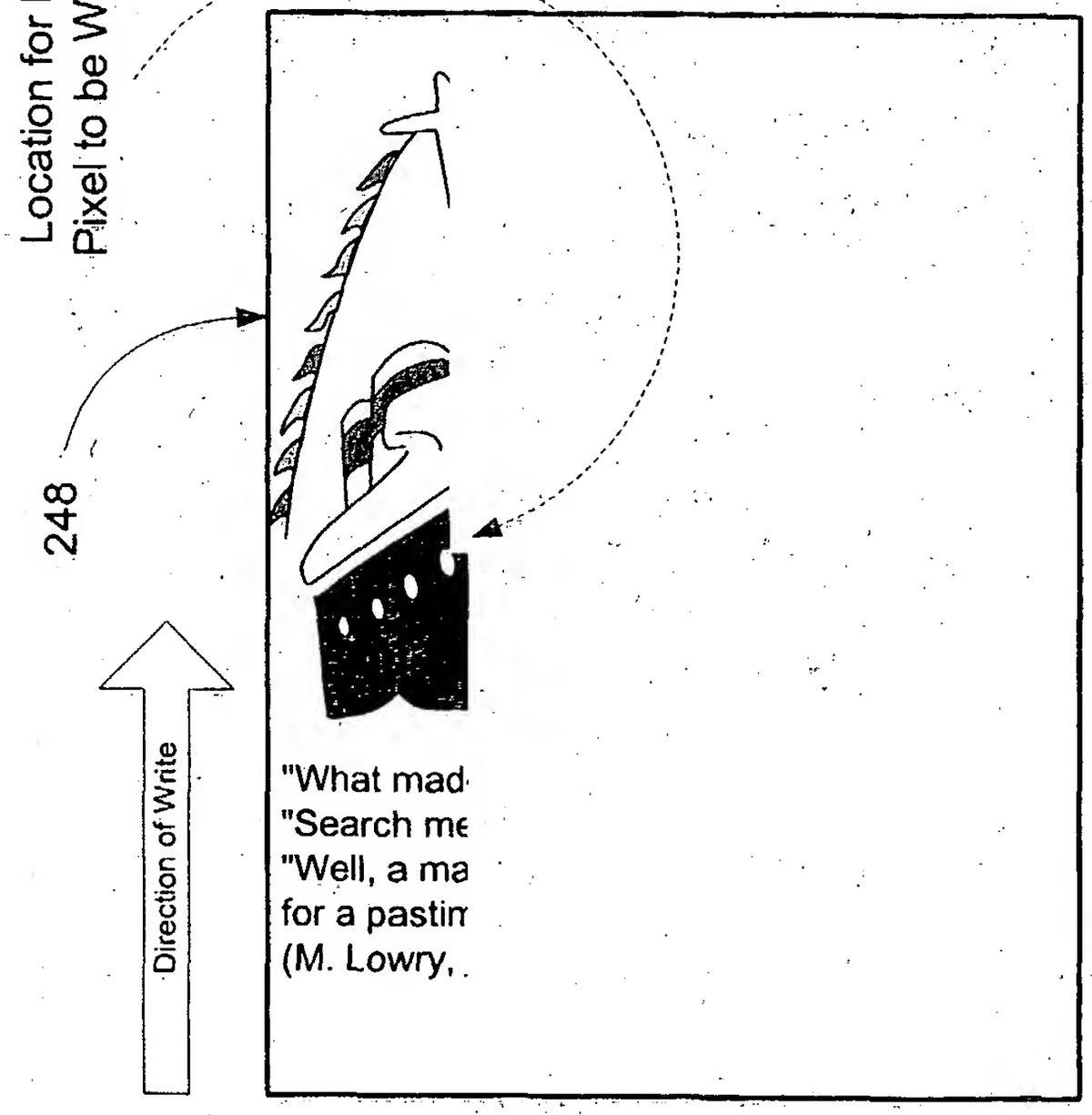

Location for Next Pixel to be Written
248
"What mad
"Search me
"Well, a ma
for a pastin
(M. Lowry,
Direction of Write
Default Frame Buffer Display (1024x768)
(equivalent to landscape display on display device)

FIG. 8A

# FIG. 8C

**Portrait Graphic (768x1024) on Portrait-Oriented Display Device**

**Write-Combine Method:**

**Rasterized Draw Pattern**

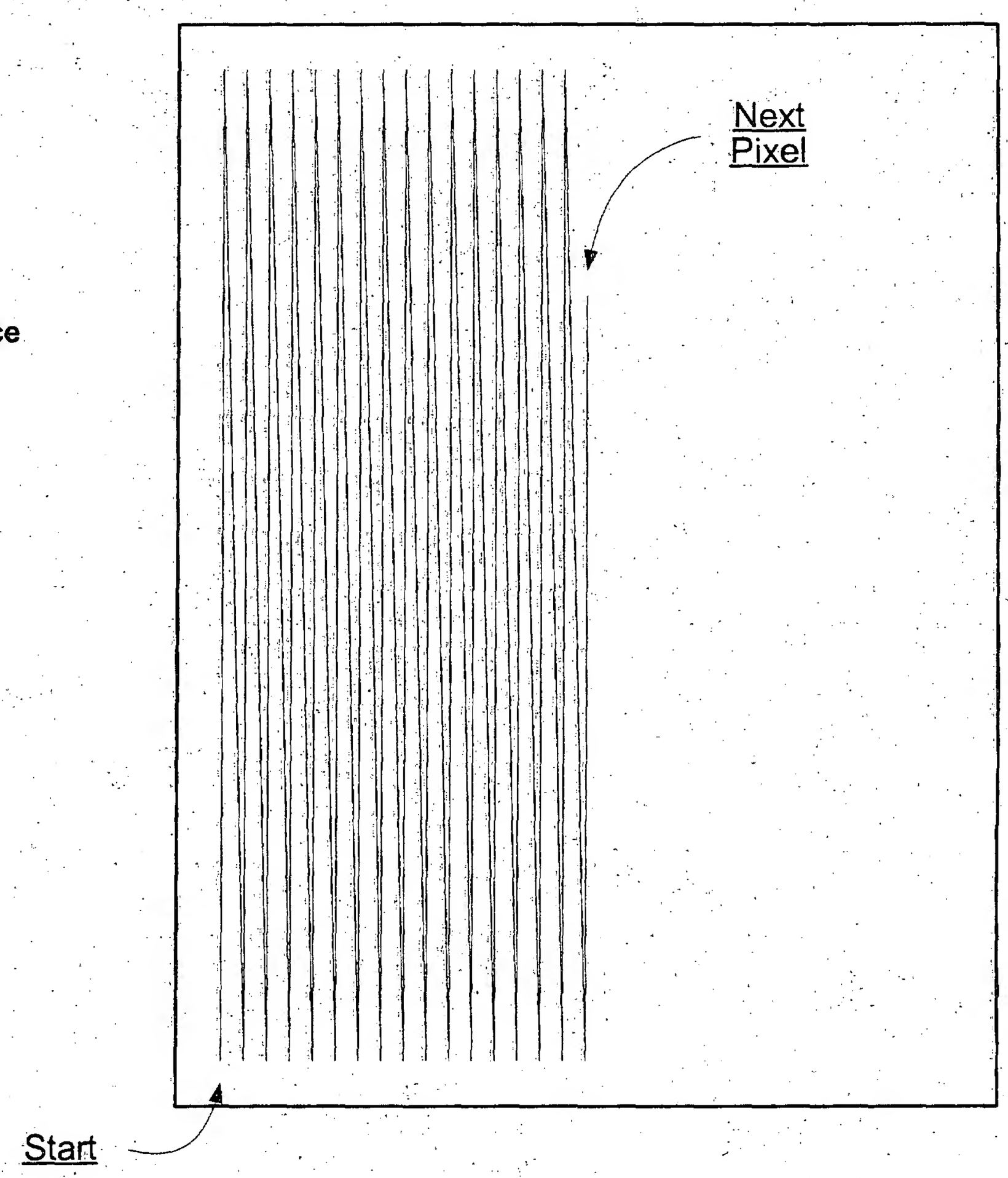


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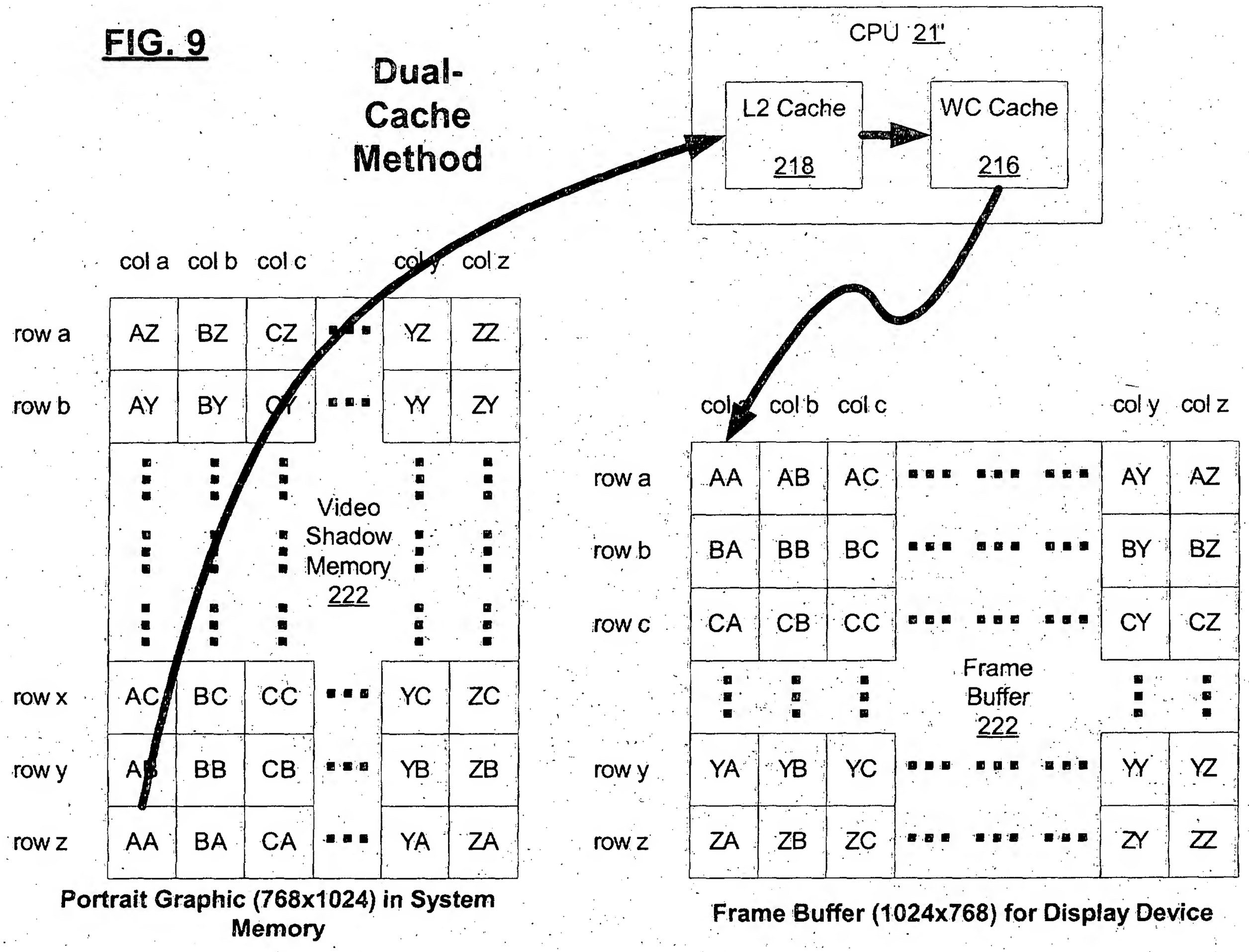
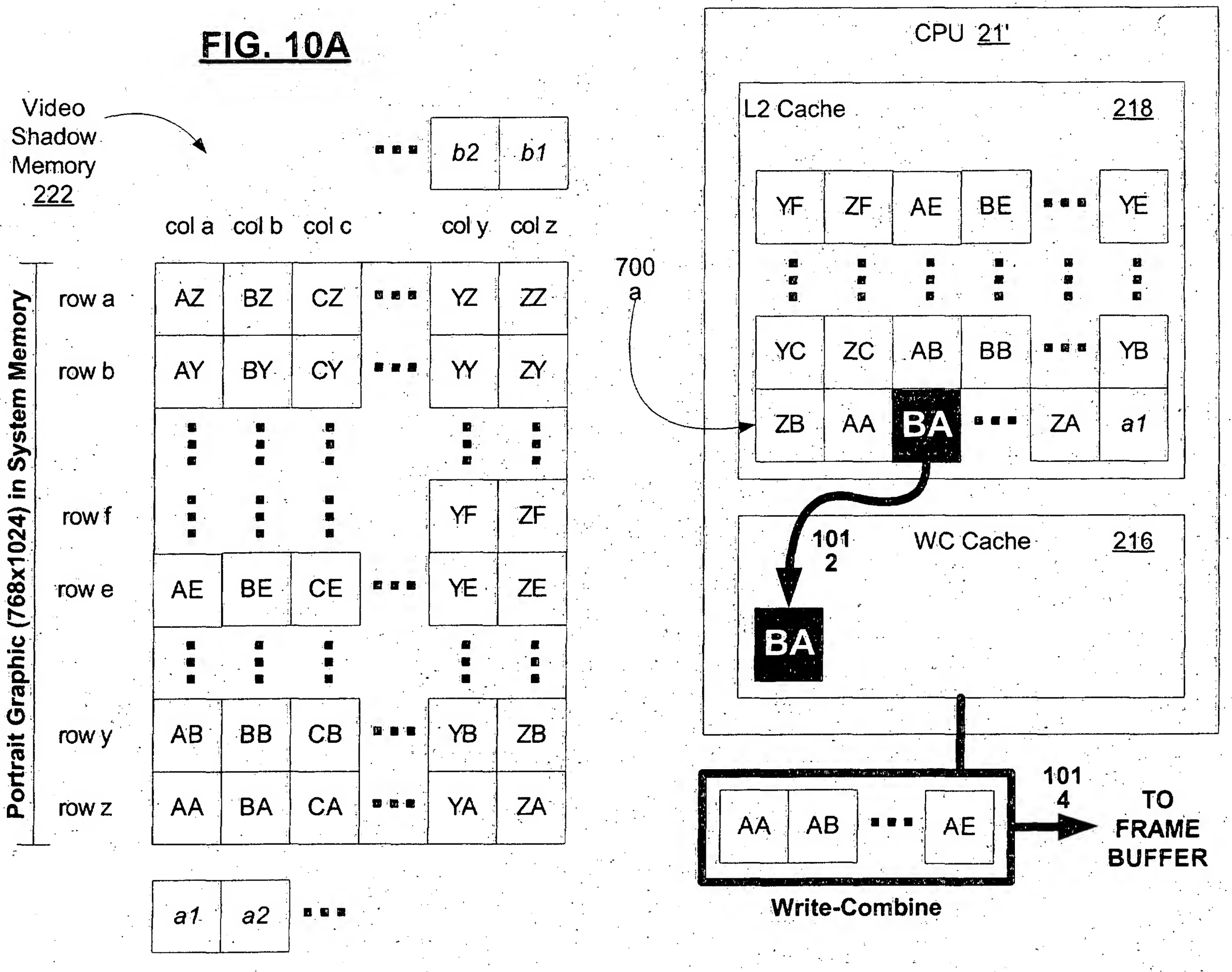
**FIG. 9**



# FIG. 10A

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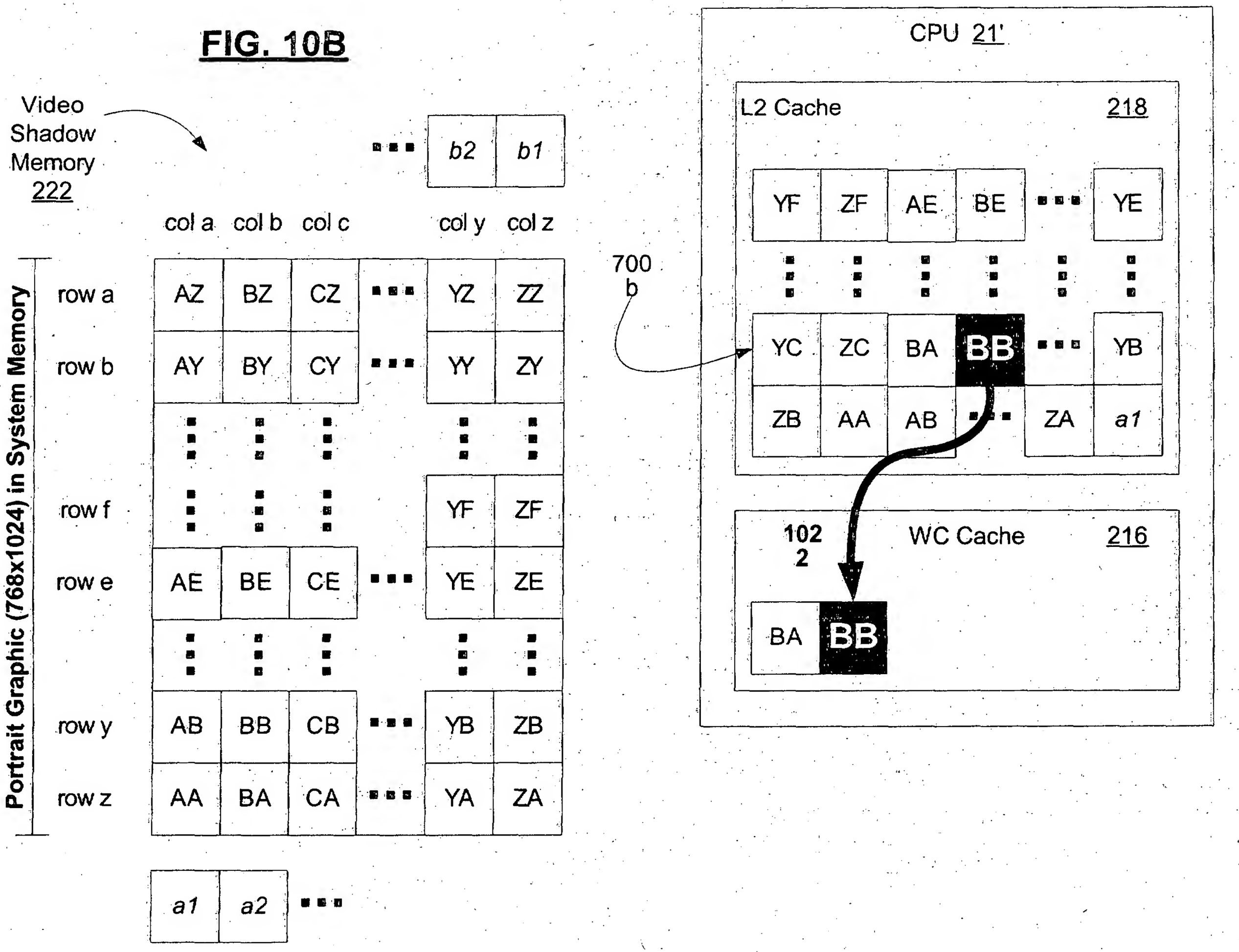
# FIG. 10B

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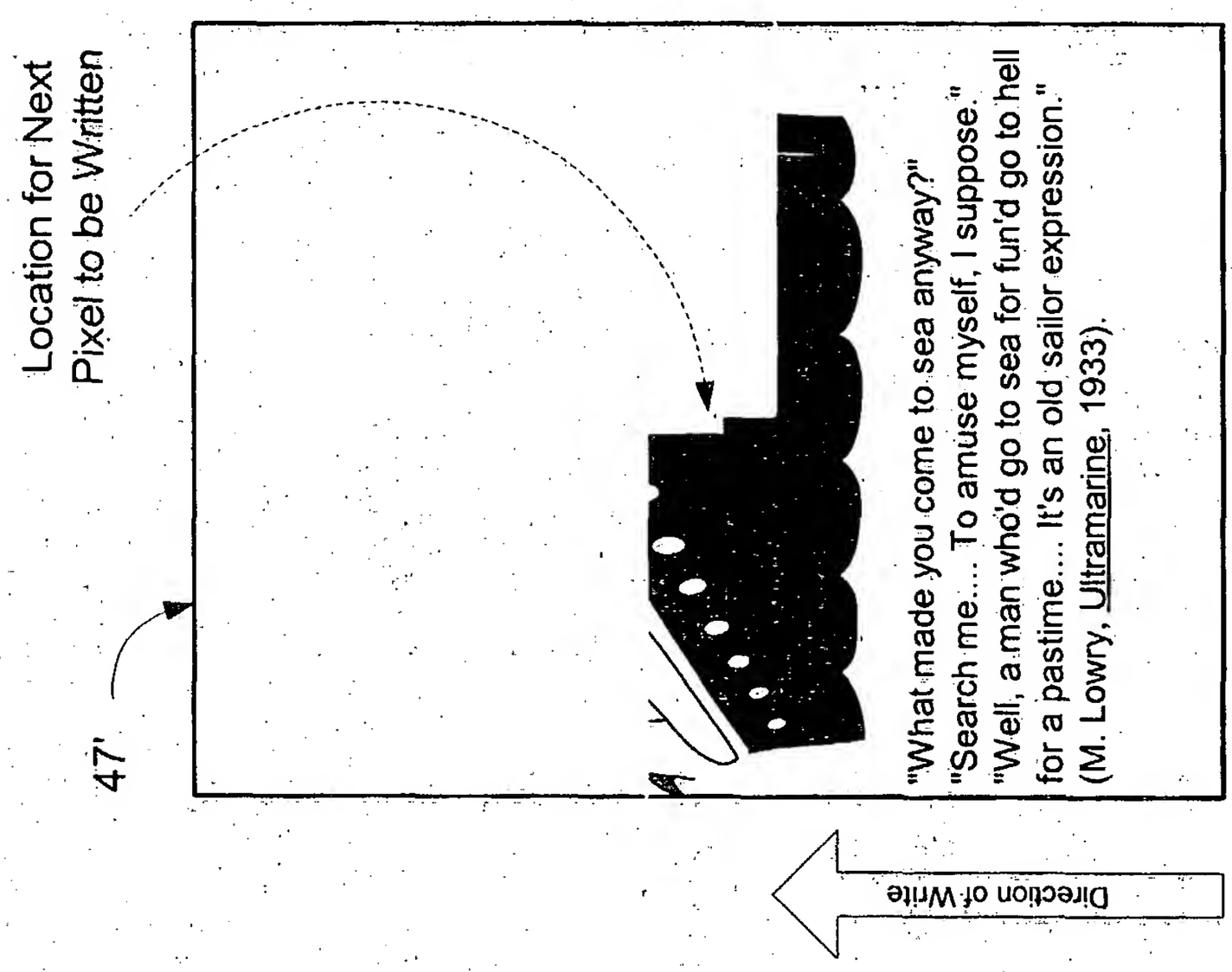


FIG. 11B

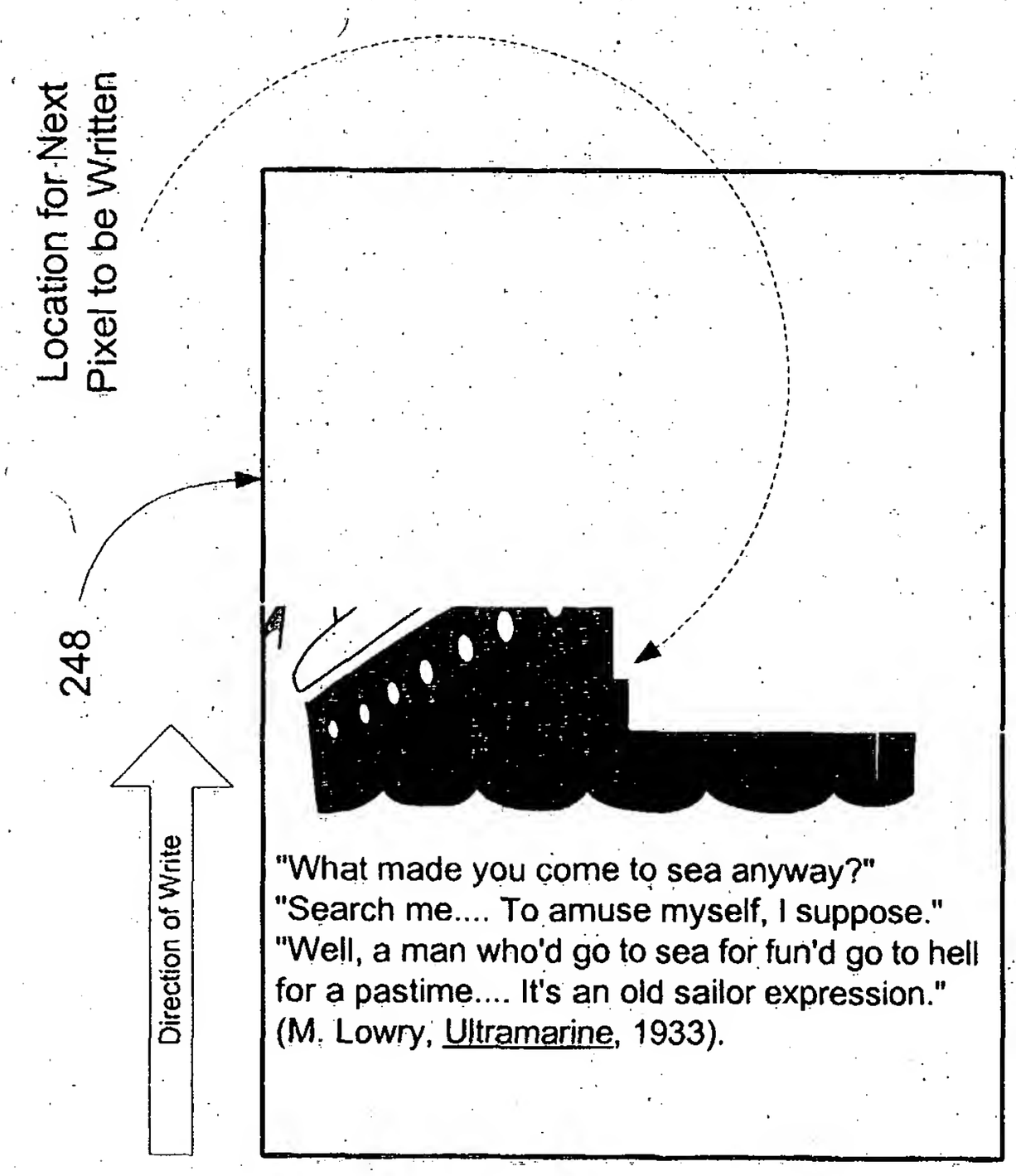


FIG. 11A

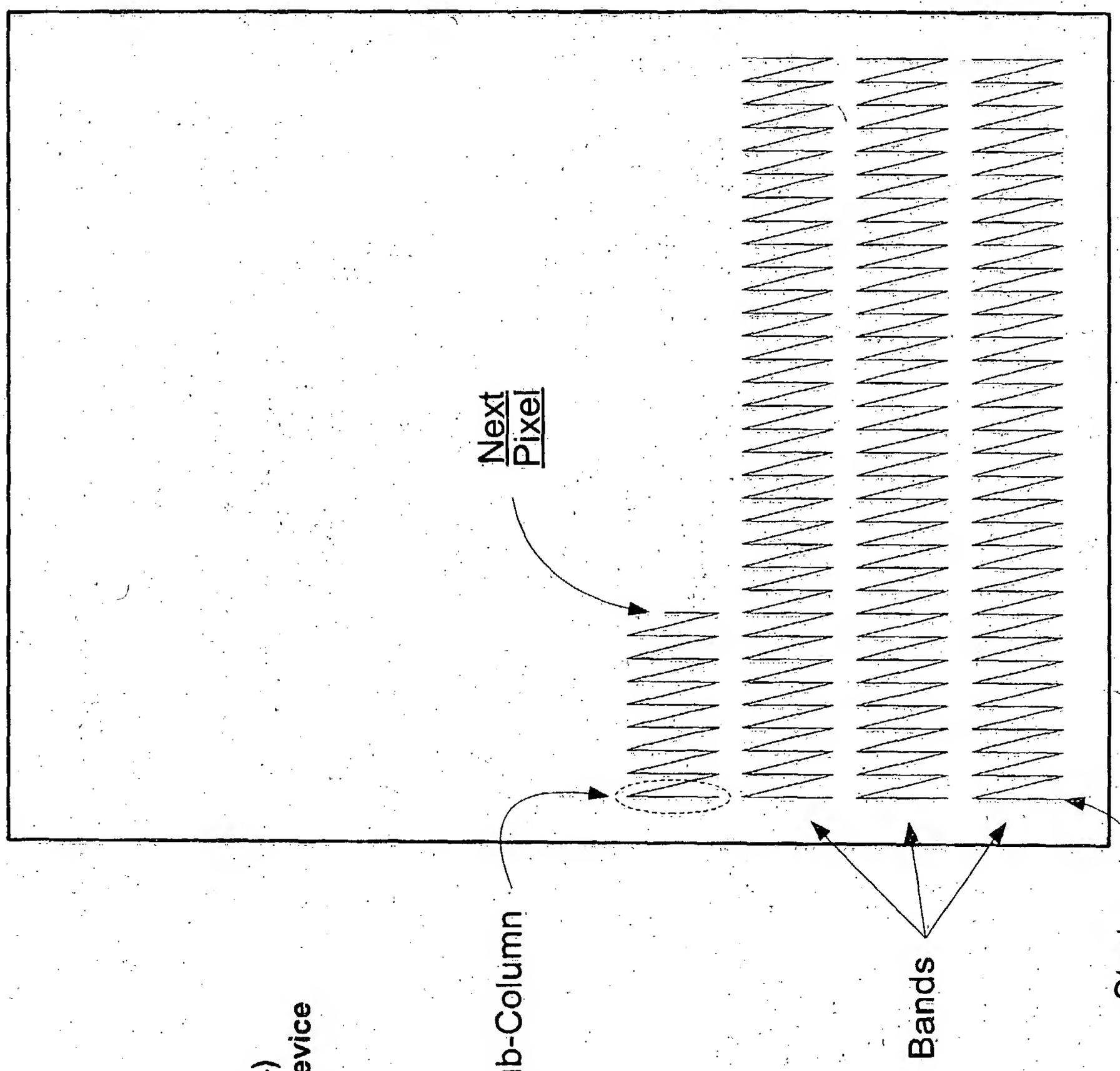
Next Pixel
Column
Bands
Start
Sub-
Dual-Cache Method:
Rasterized Draw Pattern
Portrait Graphic (768x1024) on Portrait-Oriented Display Device

FIG. 11C

# FIG. 12

## ANALYSIS OF PRESENT INVENTION VERSUS EXISTING METHODS IN THE ART

**General Analysis:**

| | RAM Reads | FB Writes | Total "Slow" Operations |
|---|---|---|---|
| Brute Force (or GPU): | 786,432 | 786,432 | 2,359,296 |
| CPU w/ L2 Cache: | 768 | 786,432 | 1,573,632 |
| Write Combine Only (approx): | 786,432 | 768 | 787,968 |
| Write-Combine & L2 Cache Optimization (approx): | 768 | 24,576 | 49,920 |

RAM Reads = 1 slow operation
FB Writes = 2 slow operations

**Assumptions for Analysis:**

| | KB: | Bytes: |
|---|---|---|
| Write Combine Buffer: | 4 | 4,096 |
| Each Pixel: | 0.0039 | 4 |
| L2 Cache for Images: | 128 | 131,072 |

| | |
|---|---|
| Total Pixels (1024x768): | 786,432 |

*This is the amount of total L2 cache memory 'dedicated' to holding RAM Read info...

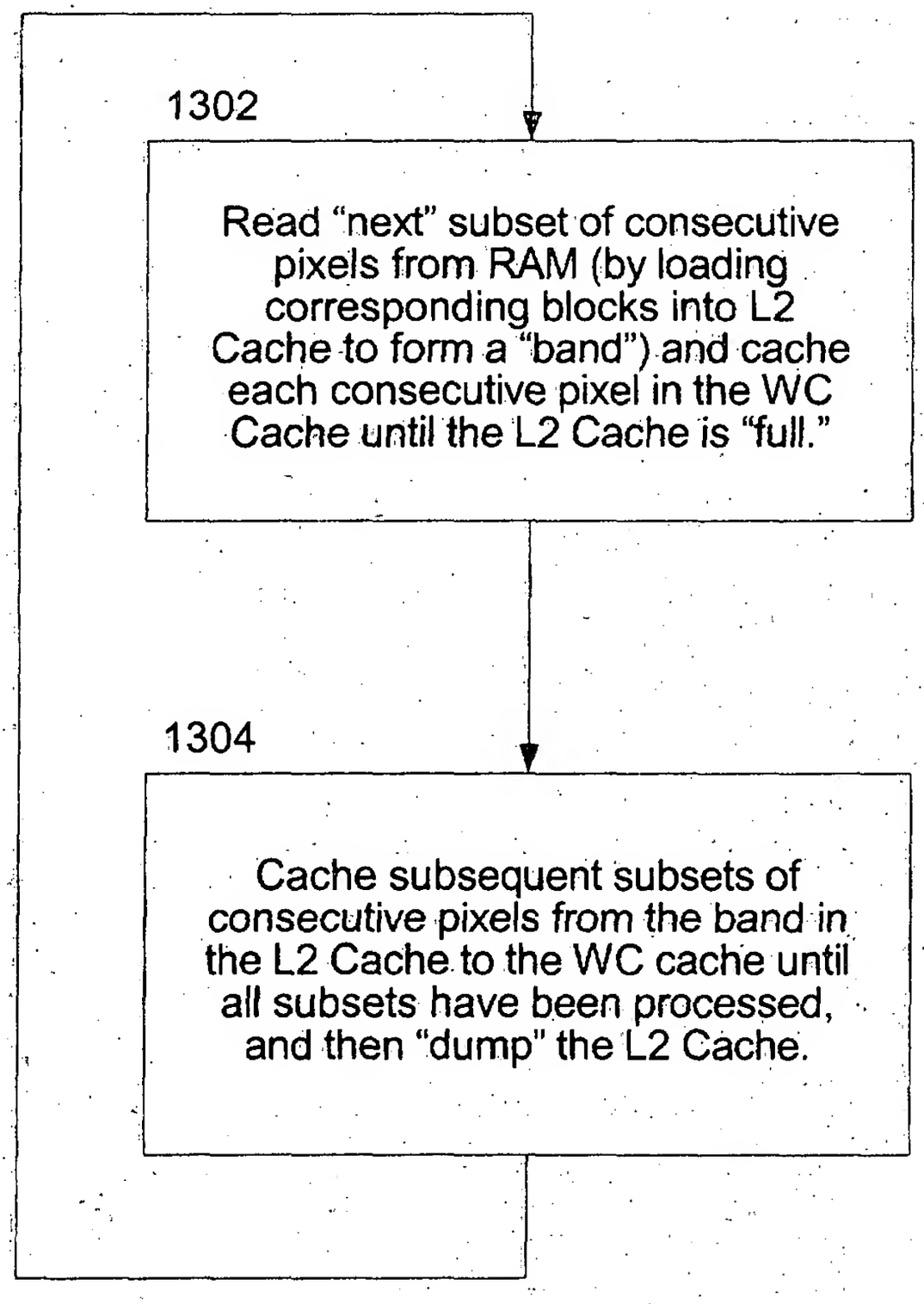
1302
Read "next" subset of consecutive pixels from RAM (by loading corresponding blocks into L2 Cache to form a "band") and cache each consecutive pixel in the WC Cache until the L2 Cache is "full."
1304
Cache subsequent subsets of consecutive pixels from the band in the L2 Cache to the WC cache until all subsets have been processed, and then "dump" the L2 Cache.

FIG. 13